FURTHER GEOPHYSICAL STUDIES OF THE HAUGHTON IMPACT STRUCTURE. . B. J. Glass[1], S. Domville[1] and P. Lee[2,], [1] NASA-Ames Research Center, Moffett Field, CA 94035, USA; [2] SETI Institute, 2035 Landings Drive, Mountain View, CA 94043, USA.. (**bglass@mail.arc.nasa.gov**)

Introduction: The approximately 23 Ma Haughton impact structure [1], located at 75º 23' N, 89º 39' W in the Canadian Arctic, on Devon Island, Nunavut, Canada is a well-preserved impact structure with an original rim diameter estimated at about 23 – 24 km [2]. Past studies, in the 1980s, did an initial survey of the Haughton structure, looking at its surface units, exposures, map surface geology, topographic and initial surveys of gravity and magnetic fields in profiles across the impact structure [3]. In reference [4] a topological outer ring and the lack of a well-defined central peak was cited as evidence that Haughton was a multi-ring structure. However other authors [3, 5] consider it more likely that the Haughton structure is a central-peak basin with simply a limited extent, and/or full peak features having been removed through glaciations and subsequent years.

The impact structure is located in approximately 2 km thickness of carbonate material on top of a gneissic basement. The impact structure itself can be described in terms of uplifted and moved blocks of altered gneissic and carbonate material with areas in the center of the crater covered with impact carbonate melts and/or reworked impact breccias.

Background: In the mid to late 1980s initial surveys of the Haughton Impact central crater found a central Bouguer anomaly gravity low, correlated with the central magnetic total field anomaly level, with an approximately 300 nT positive magnetic anomaly without any evidence in [3] of any surrounding magnetic lows. This fairly detailed gravity survey of the Haughton structure was completed in 1984 with 341 data points and found a large negative Bouguer anomaly of roughly –12 mgal. This central local minimum is characteristic of impact structures. The 1984 results showed a positive magnetic field anomaly of 700 nT at the central anomaly. The gravity low and magnetic high were postulated in [3] as likely due to highly shocked and altered sedimentary and crystalline basement rocks in the central uplift area.

Beginning in 1997 the NASA/Haughton-Mars Project (HMP) resumed field studies at the Haughton crater site. Geological, geophysical, and biological characterizations of the Haughton structure are the HMP science focus, as well as the use of the site as a Mars analog for testing instruments in platform technologies (e.g. Mars aircraft- or rover-deployed magnetometers, synthetic-aperture radar, remote data communications, etc.). Other parallel HMP geological and biological studies are cited in reference [5]. Early investigations at Haughton, under HMP, included investigations of the fault structure as well as discovering evidence of the post-impact hydrothermal activity. Early hydrothermal study results [6] have found pipe structures associated with the faulted inner annulus as well as various cavity and fracture fillings within the impact carbonatitic melt sheet [7]. In this paper results from airborne geomagnetic surveys of the structure and surrounding terrains and regional areas are presented.

Results:

Aeromagnetic Vertical Gradients

A detailed, aeromagnetic survey was conducted of the Haughton impact structure over two field campaigns in 1999 [5] and 2001[8], under the aspects of the Haughton-Mars Project. These surveys provided detailed characterization of both regional patterns and magnetic anomalies comparable to those reported by earlier authors. Figure 1 shows a perspective view of the vertical magnetic gradient. It is notable that the gradient at central magnetic anomaly peak is significantly sharper – almost an order of magnitude larger – than those of the surrounding rim and the regional highs and lows.

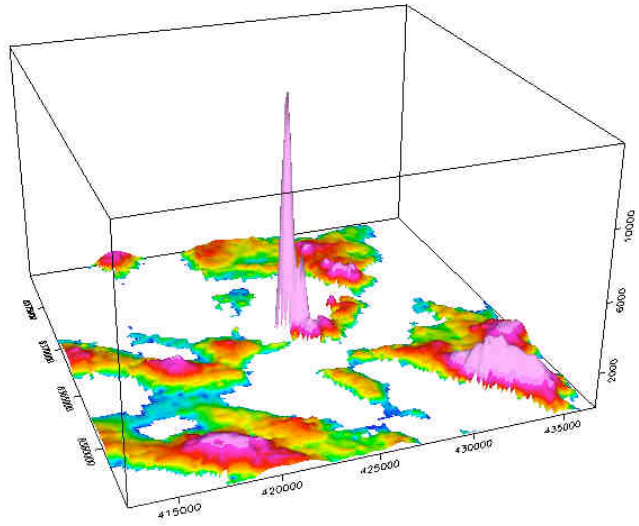

Figure 1. Perspective view of 2001 aeromagnetic vertical gradient survey values.

Gravity Data

In 1984 a fairly detailed gravity survey of the Haughton Impact Structure found a large negative Bouguer anomaly with a central local minimum. An excerpt of the 1988 gravity map [3] is given in Figure 2, which shows the central Bouguer gravity anomaly. However a higher resolution or unified gravity survey with current instruments was deemed to be desirable for comparison with the aeromagnetic data.

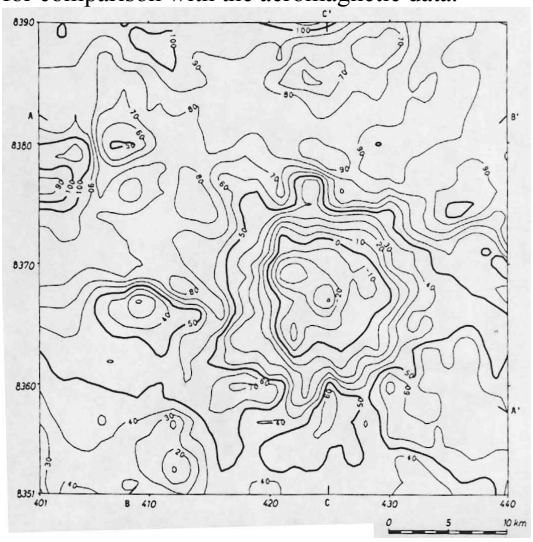

Figure 2. Gravity survey from [3] showing central Bouger negative anomaly.

In July 2003 and August 2004 new gravity stations were established and data taken. These stations extended from the central anomaly and were primarily located in the NW quadrant of the crater, and also extended to the west, beyond the aerial extent of the crater in order to compare with the regional magnetic anomalies shown in Figure 1.

Beginning with the existing 1980s gravity data, the 25 new gravity stations were added to that database. The existing data from 1984 (published in 1988 [3]) was digitized and merged with the newer data to generate the contour plot shown in Figure 3. Of the two surveys, the 2003 survey was conducted with a Lacoste and Romberg Model G gravity meter, while at the 2004 stations; the gravity data points were taken using a Scientrex CG-5 gravity meter.

Discussion: The new aeromagnetic and gravity data are consistent with previous results showing a central magnetic high with bounding lows in the crater, compatible with a local uplift with smaller regional basement anomalies around the crater. Regional total magnetic field values appear to be of comparable magnitude to the rim area anomalies especially in the southern side of the crater rim. Large anomalies and correlated magnetic and gravity highs on the south rim and further from the center are suggestive of a regional pattern overlay. However, looking in Figure 1 at the magnetic gradients on the north side of the crater rim, the lack of comparably sized gravity features there in Figure 3 suggests an additional smaller-scale induced magnetism overlaid above the regional pattern. The small magnetic gradient anomalies on the north side, given that there is found little to no gravity field variation in the area, would be candidates for correlation with hydrothermal deposits in the faulted and fractured rim zones, as postulated in [5].

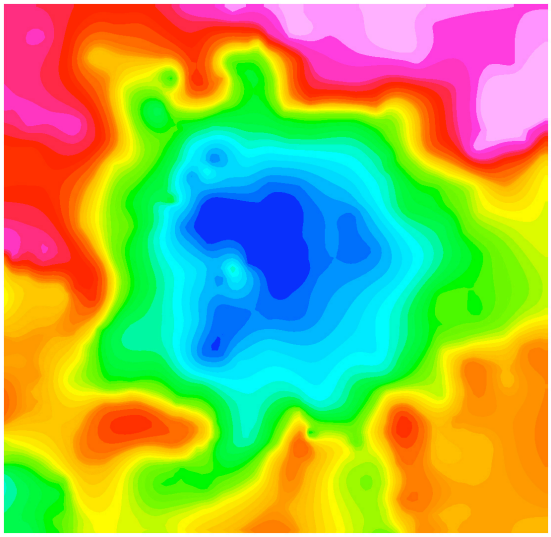

Figure 3. Merged gravity dataset contour plot.

Beyond the rim (as is currently defined) physically the structure is ambiguous. The regional pattern shown in the total field and magnetic gradient is somewhat suggestive of morphological patterns that might correspond to some sort of outer ring structure, but there is no clear evidence pointing to such a structure in these results.

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